

REMARKS/ARGUMENTS

Examiner's ruling with respect to the restriction of claims has been duly noted. Claims 10 – 31 have, accordingly, been canceled. A divisional application will be filed at the appropriate time.

Overview of the invention :

The invention discloses a method to manufacture a liftoff resist from a single material. Conventional photoresist (positive or negative) is patterned in the conventional way. Then, the top surface (only) is exposed to a beam of ions whose energy is too low to cause sputtering. Said ions penetrate a short distance beneath the photoresist surface, forming there a hardened layer. This is followed by exposure to ozone which erodes all exposed photoresist surfaces except the aforementioned hardened layer, causing the latter to overhang the unhardened layer beneath it, thereby rendering it suitable for subsequent use as a liftoff resist.

Reconsideration is requested of all rejections based on 35 U.S.C. 103:

Examiner has relied on Yamada et al. (4,904,619), in view of Bloomstein, for this rejection. Examiner begins by citing the following sections of Yamada:

Col.3 lines 29-64, col. 4 lines 63-68, col. 5 lines 1-13, and figs. 1a through 1d.

Examiner then argues that, in said cited sections, Yamada teaches, inter alia, the following steps:

.....performing ion beam irradiation so as to cause hardening of the resist's surface on the top portion (upper surface hardened).....such that the bottom portion (shadowed region) of the resist pattern remains unhardened, exposing the resist pattern to oxidation using plasma etching resulting in the undercut of the photoresist pattern

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(unhardened bottom portion of the resist pattern eroded), wherein the top portion of the resist pattern overhangs the bottom shrunk portion.....

We respectfully disagree with examiner's interpretation of what these various sub-sections of Yamada are teaching. Starting with FIGs. 1a through 1d, the process shown comprises using photoresist mask 15 to pattern layer 14 (FIG. 1a), followed by shrinking mask 15, OVER ITS FULL LENGTH, through oxygen gas plasma etching (FIG. 1b), the purpose being to expose a small shelf of layer 14. Then, layer 16 is deposited (FIG. 1c) following which the resist is removed, so liftoff occurs (FIG. 1d).

Starting in col. 3 line 44, Yamada comments that the cross-section of the resist should preferably be terraced so as to have a slight overhang. Yamada makes no reference to a hardened layer that is limited to the top surface of the resist. Instead, as becomes clear further on, Yamada's overhang is achieved by giving the resist a trapezoidal profile with the wider side being the top surface. Yamada then goes on to describe his method for forming said overhang and, in doing so, teaches away from the present invention in three fundamental ways that we have italicized in the following quotation taken from the sections cited by examiner:

"....harden the resist film surface by *sputter cleaning with high energy particles.....the conditions of oxygen sputter cleaning and plasma etching* have a decisive factor in obtaining a desired cross-section of the resist film".

Sputter cleaning differs from exposure to an ion beam (the method taught by the present invention) in several important respects. In particular, sputtering implies the removal of material from the surface that is being sputtered whereas the present invention explicitly states that no sputtering of the surface is to occur. Furthermore, during sputtering all exposed surfaces, not just the top surface, get sputtered. High energy particles are explicitly excluded by the present invention (see, for example, "said ion beam comprising ions whose energy is too low to sputter said layer of photoresist" on line 6 of claim 1). Oxygen sputter cleaning and plasma etching are not the methods

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used to selectively reduce the dimensions of the resist. What is used is exposure to ozone.

Examiner's reliance on Yamada then continues, examiner arguing that (in col. 5 lines 1-5) Yamada discloses "that the ion beam has the claimed voltage". This appears to be a misquotation as neither ion beams nor voltages are mentioned in the cited extract. Next, examiner argues that (in col. 5 lines 1-16) Yamada teaches a top hardened layer that extends to about 50 nm. This also appears to be a misquotation as no such information is provided there. Furthermore, such information as does appear there refers to the shrinkage of the resist not to the depth of a hardened layer (as in our claims 6 and 34).

Still citing Yamada, examiner refers to col. 5 lines 10-12 where, examiner states, it is disclosed that "the hardened layer (unetched overhang) overhangs the shrunk bottom resist by about 0.2 nm (claims 8, 35)". Here, examiner appears to not have noticed that there is no hardened layer as such but rather a gradual change in resist width from top to bottom (trapezoidal shape) --- quite a different geometry for the resist profile from that taught by the present invention. Furthermore, since the total change in resist width when going from top to bottom is given as 200 nm it follows that the top of the resist overhangs the bottom by 100 nm, not 0.2 nm as quoted by examiner. In our claim 8 we teach an overhang of between 0.01 and 0.1 microns (between 10 and 100 nm).

As we have noted above, the present invention employs exposure to ozone to selectively reduce the dimensions of the resist whereas Yamada teaches the use of oxygen sputter cleaning and plasma etching. Examiner cites Bloomstein (col. 11 lines 60-67 and col. 12 lines 1-7) as teaching that exposure to ozone reduces the dimensions of a resist. In actuality, what Bloomstein teaches in the cited section is that exposure to ozone makes the resist easier to develop. No change in dimensions is involved.

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In summary, Yamada teaches a method to manufacture a liftoff resist by using high energy sputtering. This results in a resist having a trapezoidal cross-section. The present invention teaches use of a low energy ion beam to harden the resist surface followed by shrinkage of the unhardened portion by exposing it to ozone.

Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

Respectfully submitted,

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